White Paper No. 23 – Evaluation of Cost and Implementability of Alternative C2B for Operable Unit 3 and Operable Unit 4

Response to Comments on the

Proposed Remedial Action Plan for the Lower Fox River and Green Bay

October 2001

This Document has been Prepared by the

Wisconsin Department of Natural Resources
Madison, Wisconsin

June 2003

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Abstract

The paper addresses concerns raised during the public comment period for the *Final Remedial Investigation for the Lower Fox River and Green Bay, Wisconsin* (RI) (RETEC, 2002a), the *Final Feasibility Study for the Lower Fox River and Green Bay, Wisconsin* (FS) (RETEC, 2002b), and the *Proposed Remedial Action Plan, Lower Fox River and Green Bay* (Proposed Plan) (WDNR and EPA, 2001), on the implementability and cost of the Proposed Plan concerning Operable Units (OUs) 3 and 4. More specifically, concerns were raised concerning the possible use and cost of a pipeline to remove the dredge slurry from the River and the size and cost of the de-watering and disposal cells recommended in the Proposed Plan. To address these concerns, the Wisconsin Department of Natural Resources (WDNR) reviewed technical and cost issues associated with the Proposed Plan for these two Operable Units. This work is discussed in the following white paper.

1 Introduction

In the Proposed Plan for the Lower Fox River (WDNR and EPA, 2001), the proposed remedy for OU 3 and OU 4 is Alternative "C2." This alternative includes dredging, pipeline transport, passive dewatering, and disposal with the dewatering and disposal in separate but adjacent facilities. Comments received by WDNR and the United States Environmental Protection Agency (EPA) during the public comment period expressed concern over the implementability and cost associated with the length and placement of the dredge slurry pipeline as well as the sizing of the dewatering and disposal facilities. The purpose of this white paper is to evaluate implementability and cost concerns for this alternative to review these issues and provide a basis for responding to these concerns.

For purposes of the Proposed Plan and Record of Decision (ROD) for OUs 3 through 5, the alternative of separate but adjacent dewatering and disposal facilities managing the dredged material from both OUs 3 and 4 together was evaluated. In the Final FS released in 2002, alternatives were presented for both combined and separate dewatering and disposal facilities. These are listed as Alternatives C2A and C2B, respectively. Alternative C2B more clearly identifies separate dewatering and disposal facilities discussed in the Proposed Plan.

As described in the FS, Alternative C2B includes some features such as the addition of lime and solidification due to a short passive dewatering duration. This specific set of assumptions was one of many sets of assumptions that could have been used in the FS. Upon further evaluation, the Agencies decided that some features such as the lime addition and solids processing were not necessary for this alternative.

Consequently, the Agencies have reexamined the implementability and cost of Alternative C2B as part of the response to comments so a representative feasibility study-level alternative and cost estimate can be presented. To conduct this evaluation, conceptual design issues such as sizing of the dewatering and disposal cells along with operational constraints from Alternatives C2A and C2B from the FS were considered. The set of assumptions used in this evaluation are based on the trade-off between project duration, land availability, final dewatered sediment solids content, and cost. In addition, these dewatering choices impact the design and operations of the disposal facility.

The remedy in the OUs 3 through 5 ROD includes a longer duration of passive dewatering, additional passive dewatering cells, and a greater assumed solids content at the end of dewatering (35 percent). The remedy assumes that intermediate drainage layers can be incorporated into the landfill construction.

2 IMPLEMENTABILITY

Section 6 of the Final FS for the Lower Fox River and Green Bay (RETEC, 2002b) covers the screening of applicable remediation technologies, including the transfer, dewatering, and disposal of dredged material. Much of the information in this white paper evaluation was considered in the development of the Section 6 of the FS and as well as earlier drafts of that document.

2.1 Pipeline

Pipeline technology has been used to transfer sediment dredge slurry over long distances. This has been a common practice in mining facilities and at dredging operations. An example is White Rock Lake in Dallas, Texas (Hagler, 2001). In that case, a pipeline with a length of 20 miles was used to transport dredged sediments over land. At the USX portion of the Grand Calumet River Project, a 3-mile in-water pipeline with an 18-inch diameter is being used. In a Wisconsin case, hydraulically dredged sediments were transferred via pipeline from the Grubers Bay Grove sediment project, part of the U.S. Army Badger Army Ammunition Plant remediation, to the on-site disposal location, a distance of about 0.7 mile.

In FS Section 7, there is a discussion concerning the application of this pipeline technology to OU 3 (page 7-97) and to OU 4 (page 7-137) as part of a proposed remedy. This conceptual pipeline design includes the use of a 15-inch polyethylene pipe inside a 20-inch steel pipe that would travel to a disposal location with booster pumps located along the route. Additional assumptions include that the pipeline would be 18 miles in length and that there would be four booster pumps along the route. While no route has been selected yet, it is possible to place the pipeline adjacent to an existing recreational route, in the River, along public right of ways, or some combination thereof. Pipeline routing is a concern. The specific route and details concerning the design and construction of a pipeline along any specific route or combination of routes is a design consideration to be addressed in the future. The inability to route such a pipeline could result in increased cost for this approach, or, the use of a different, potentially more costly, dredge material transport method.

2.2 Passive Dewatering and Disposal

Passive dewatering technology was evaluated in Section 6.5.1 of the FS. Passive dewatering represents a feasible "low tech" approach for dewatering sediments. In this particular alternative, the application of this technology relies on gravity settlement of solids conducted in upland ponds. This approach is consistent with the approach used at the Bayport facility managed by Brown County for the management of navigational dredge materials in conjunction with mechanical dredging. Use of passive dewatering cells can result in the need for large land areas. Finding a location for such a facility could pose a difficulty due to the large land areas necessary for the dewatering cells.

Management of PCB-contaminated material in an upland disposal location is a proven technology. In the two Lower Fox River demonstration projects, this approach was successfully utilized for management of the dredge materials as it has been at numerous other sites. Upland disposal is also a protective risk reduction approach that does not allow for PCBs to be reintroduced into the food chain. The size of the disposal facility is dependent upon the solids content of the material and the compressive strength of the dewatered sediment. As a general rule of thumb, the lower the percent solids, the less the compressive strength, the less ability there is to place waste in lifts and the greater the area needed. The larger the area needed, the greater the area that needs to be lined for disposal, resulting in higher disposal cost. An important aspect of design is to optimize the dewatering step to get a high percent solids to reduce the size of the disposal cells.

From an implementability perspective, the design and operation of dewatering and disposal facilities must consider the following: size of the dewatering cell, the filling sequence of and hence the number of cells, the percent solids at which the dredge material enters the cells, how water will be withdrawn from the cell, the percent solids of the material that will exit the dewatering cells, how the material will be removed from the dewatering cells and placed into the disposal cells, what will be the lift height within a landfill cell, what is the compressive strength, will the material continue to dewater in the disposal cells, the need for an intermediate drainage layer between lifts, the depth of cut of the landfill cell, liner and cover design requirements for the disposal cells, and when closure is needed.

2.2.1 Dewatering. Combining the estimated size of the dewatering cells for Alternative C2B for both OU 3 and OU 4 result in a total area of 218 acres. To add a degree of conservatism to this approach, this area was multiplied by 1.5 for a total area of 327 acres. This area, if split among cells and allowing for berms could provide for construction of multiple cells. Depending upon operation needs, cells could be loaded every third or fourth year. This would allow for an operational approach that would provide for loading of a cell while supernatant was being decanted of off the cell, a year to dewater the cell, and a final year of dewatering prior to the material being removed at the end of the third year and then the cell being readied for more dredge slurry the following year. Dewatering would take place by decanting, bottom drainage, desiccation, vegetative growth, evapo-transpiration, and could be enhanced by disking or other methods. It is assumed that the material would be approximately 35 percent solids when it leaves the dewatering cell. An end loader filling multiple dump trucks could conduct transfer to the adjacent disposal facility. The relationship between volume and percent solids is included in the table below. This higher percent solids may make it worthwhile to place more emphasis on the additional dewatering cell(s) rather than construction of additional landfill capacity. The size, operation and the number of cells will be optimized during the design process.

Combined OU 3 and OU 4 Weight and Volume		
Percent Solids	**Weight (tons)**	**Volume (cubic yards)**
30%	7,739,200	7,580,000
35%	6,633,600	6,205,500
40%	5,804,400	5,234,000
45%	5,159,500	4,486,500
50%	4,643,500	3,928,500

2.2.2 Disposal. Combining the estimated size of the disposal areas for Alternative C2B for both OU 3 and OU 4 result in a total area of 121 acres. This area, if split among cells and allowing for berms could provide for construction of two cells of approximately 50 acres apiece with a fill height of approximately 20 feet. Each cell could be loaded every other year in lifts of 6 to 7 feet. Placement of the material in such a manner could allow for further dewatering as the material is placed and in subsequent years as the material consolidates due to gravity and further placement of material from subsequent lifts. Dewatering layers could be placed in between lifts to enhance dewatering and consolidation. Consolidation would not likely be enhanced through typical compaction techniques. As is pointed out in the dewatering discussion, consolidation and increased percent solids affects the size of the disposal facility in terms of both total land area and ability to fill using vertical airspace rather than expanding horizontally and adding to land needs. Leaving the cells open for a time period of 2 or so years will allow for further drying and consolidation of the material prior to final closure. Once closure takes place, further settlement may take place due to the cover weight and self-weight consolidation. Maintenance of the cover will be necessary to address further settlement.

Of particular concern in the siting of such facilities is the availability and acquisition of the large land areas necessary. This issue will need to be addressed as part of the post-ROD siting process as well as negotiations with local communities. It should be noted that the more difficult it is to site these facilities locally, the greater the cost will be.

3 COST

Costs at the feasibility study level are expected to be within a -30 to +50 percent range per Superfund guidance. While this is a broad range, it is meant to provide sufficient information on cost for decision-making without having to go into a detailed design of the alternative. Estimated costs included in the Proposed Plan for this alternative was $30.9 million for OU 3 and $169.6 million for OU 4. The total cost of this plan for both OUs was estimated at $200.5 million. Details of this cost estimate can be found in Appendix H of the Final FS for the Lower Fox River and Green Bay (RETEC, 2002b). Sources of the unit cost information included in Appendix H include the R.S. Means Heavy Construction Cost Estimating Data, 2000, past reports and studies, information from various consulting firms and contractors, and professional judgment.

To more clearly evaluate costs for this combined OU 3 and OU 4 alternative, the cost information included in Appendix H of the FS for Alternative C2B was reviewed to refine costs for Alternative C2B. Unit costs were considered along with the source of the unit cost estimate and the conceptual FS design. A decision was then made as to whether this was a reasonable cost for a "feasibility study" level of effort. Furthermore, the FS has done a complete cost estimate for each Operable Unit. This results in some duplication of costs such as the pipeline construction, certain landfill operation and monitoring costs, as well as wastewater treatment costs. In reviewing these cost estimates as part of this evaluation, these "shared" costs were identified and are only included once. This combined OU 3 and OU 4 cost summary is included as Attachment 1 to this white paper and is entitled *Basis for Preliminary Cost Estimates – Little Rapids to De Pere and De Pere to Green Bay*. This cost summary provides the same level of detail as does Appendix H of the Final FS.

3.1 Pipeline

The source of the unit costs for pipeline are listed in Appendix H of the FS as are the conceptual design assumptions for the pipeline. These assumptions for the pipeline construction and operation included in Appendix H are consistent with the text in the FS. Furthermore, since the cost estimates for the FS included two pipelines (one each for OU 3 and OU 4), only the OU 4 pipeline is carried forward. Applying the unit cost to the conceptual design result in a cost for pipeline construction were approximately $17,155,000 or about $180 per foot.

3.2 Passive Dewatering and Disposal Facilities

3.2.1 Dewatering. The cost from Attachment 1 for the combined OU 3 and OU 4 from Attachment 1 gives an estimated cost of $58,300,000 for the construction of approximately 327 acres of dewatering cells. These costs cover land purchase, berm and grade construction, and liner placement. On a per-acre basis, this leads to a cost of $178,300 per acre. This is a reasonable cost estimate for this type of facility when a liner is required.

3.2.2 Disposal. The cost from Attachment 1 for the combined OU 3 and OU 4 from Attachment 1 gives an estimated cost of $36,600,000 for the construction and closure of approximately 121 acres of disposal cells. These costs cover land purchase, berm and grade construction, liner placement, as well as cover construction. On a per-acre basis, this leads to a cost of $302,000 per acre for landfill construction and closure. This is a reasonable cost estimate for this type of disposal facility with a liner and cover requirement.

3.3 Unit Processing Fee

There is a cost associated with transferring, processing, and transporting material within and between the dewatering facility and the disposal facility. In the Final FS, this cost is roughly $38 per ton. This figure included the purchase and processing to add lime to the dewatered sediment to achieve a high percent solids and strength of the dredge material more quickly as well as the transfer of the material over public roads from the dewatering facility to the disposal facility.

Following the proposal for managing the dewatered material included in the implementation discussion above was a unit processing cost of roughly $3.5 to $4 per ton. Using a cost of $4 per ton for a total tonnage of 6.6 million tons (at 35 percent solids) equates to a cost of $26,400,000.

3.4 Combined OU 3 and OU 4 Costs

Costs covering dredging, water treatment, local siting, and institutional controls also need to be considered for the revised Alternative C2B need cost estimate. These costs along with the costs for pipeline, dewatering, and disposal are included in the table below which has the combined cost for the revised Alternative C2B cost estimate. Attachment 1 is a revised Alternative C2B cost table based on Appendix H of the FS. In that more detailed table, the various costs are readily identifiable.

Revised Estimated Alternative C2B Costs	
Sediment Removal	$112,500,000
Sediment Dewatering	$58,300,000
Disposal	$96,100,000
Water Treatment*	$7,300,000
Institutional Controls*	$9,000,000
Total OU 3 and 4 Cost =	**$283,200,000**

Costs come from Attachment 1 which is based on refined Appendix H costs from the Final FS; a combined OU 3 and OU 4 alternative.

3.5 Unit Cost

The estimated *in-situ* contaminated sediment volume to be dredged from OU 3 is 586,800 cubic yards (cy) and the estimated *in-situ* volume from OU 4 is 5,879,500 cy for a combined amount of 6,466,300 cy. At an estimated cost of $283,200,000, the unit cost is $43.80 per cy. Individual costs are based on the volume in each OU and are included in the following table.

Estimated Costs per Operable Unit		
	Sediment Volume in OU	**Cost per OU Based on Volume**
Operable Unit 3	586,800 cy	$25,700,000
Operable Unit 4	5,880,000 cy	$257,500,000
Total	**6,466,800 cy**	**$283,200,000**

The ROD for OUs 3 through 5 calls for the removal of Deposit DD from OU 2 as part of the OU 3 remedy. The estimated volume of contaminated sediment in Deposit DD at a concentration above 1 ppm is 9,000 cy (6,920 cubic meters from RI Table 5-13). At a unit cost of $43.80 per cy, the estimated cost is $0.4 million. Doubling this to account for any additional piping, staging costs, etc., brings the estimated cost to remove Deposit DD to $0.8 million. This cost is added to the cost to remediate OU 3. Furthermore, using the unit cost to assign costs to the different OUs leads to a cost estimate of $26.5 million for OU 3 (including Deposit DD) and a cost of $257.5 million for OU 4. Consequently, the combined cost estimate for OU 3 and OU 4 is $284 million.

4 CONCLUSIONS

Based on this evaluation, the following conclusions regarding cost and implementation can be reached.

4.1 Cost

- The cost for separate dewatering and disposal facilities are above what was included in the Proposed Plan, but are less than what is estimated in the Final Lower Fox River and Green Bay FS. The cost estimate has increased from $200.5 million to remediate these two units to $284 million, or an increase of about 42 percent. Some cost savings may be incurred in the design in areas such as the possible flexibility in the design of the liner of the disposal facility as well as in operational efficiencies.

- The basis for establishing unit costs for cost estimates are reasonable and include source such as the R.S. Means Heavy Construction Cost Estimating Guide, past reports and studies, information from various consulting firms and contractors, as well as professional judgment. Applying these sources generate cost estimates that are within the -30 to +50 percent feasibility study cost range set forth in EPA guidance.

- Cost savings are incurred by selecting the same alternative for both OU 3 and OU 4.

4.2 Implementability

- Overall, Alternative C2B is implementable and a technically feasible alternative. There are, however, many technical and operational issues that must be considered in the final design, construction, and operation of the alternative.

- Use of a pipeline to transfer dredge slurry is an implementable and a feasible technology. Final route placement, size of the pipe, number of pumps and pump stations, as well as the length of the pipeline will be part of the final design.

- Siting of the dewatering and disposal facilities are land intensive and could be difficult to site due to availability and acquisition of land. Siting of the disposal facility will need to follow the state siting laws.

- Addressing items such as siting, technical issues as well as operational, monitoring, and closure plans will be important considerations in the design phase of this project. As a final design is developed, cost estimates will be able to be more refined.

- Per-acre cost estimates developed as part of this evaluation fall within typical cost for disposal and closure of disposal facilities. Information to be collected as part of the pre-design sampling effort concerning physical and chemical properties of the dewatered sediment may allow for modification of liner specifications that may afford further savings.

5 REFERENCES

Hagler, 2001. Personal communications between ThermoRetec and Bob Hagler of Hagler Systems in Augusta Georgia, regarding performance of the 20-mile slurry pipe run used at White Rock Lake, Texas. June 18.

R.S. Means Heavy Construction Cost Estimating Guide, 2000 and 2001.

RETEC, 2002a. *Final Remedial Investigation for the Lower Fox River and Green Bay, Wisconsin*. Prepared for Wisconsin Department of Natural Resources by The RETEC Group, Inc., St. Paul, Minnesota. December.

RETEC, 2002b. *Final Feasibility Study for the Lower Fox River and Green Bay, Wisconsin*. Prepared for Wisconsin Department of Natural Resources by The RETEC Group, Inc., Seattle, Washington. December.

WDNR and EPA, 2001. *Proposed Remedial Action Plan, Lower Fox River and Green Bay*. Wisconsin Department of Natural Resources, Madison and Green Bay, Wisconsin and United States Environmental Protection Agency, Region 5, Chicago, Illinois. October.

ATTACHMENT 1

BASIS FOR PRELIMINARY COST ESTIMATES – LITTLE RAPIDS TO DE PERE AND DE PERE TO GREEN BAY

White Paper No. 23 Attachment 1
Cost Comparison for OU 3 and OU 4
Alternative C2B - Lower Fox River

Activity	Final FS Costs			Proposed Plan		Basis for Cost Benefit
	OU 3	OU 4	OU 3 and OU 4	Joint OU 3/OU 4	Cost Benefit	
Sediment Removal	$24,700,000	$98,900,000	$123,600,000	$112,500,000	$11,100,000	Single mobilization and single pipeline constructed.
Sediment Dewatering	$22,100,000	$19,900,000	$42,000,000	$58,300,000	($16,300,000)	Assumed 35% solids at completion of dewatering rather than 30% due to longer dewatering duration – 2.5 years versus 6 months. Savings more than offset by increase in number of cells and associated acreage.
Water Treatment	$4,600,000	$6,900,000	$11,500,000	$7,300,000	$4,200,000	Single water treatment system and discharge piping to river.
Sediment Disposal	$44,000,000	$359,400,000	$403,400,000	$96,100,000	$307,300,000	Eliminated lime purchase and soldification from dewatering process due to increased dewatering time frame and associated increased solids content. Decreased haul time from 2 hours per load to 0.5 hour.
Institutional Controls	$4,500,000	$4,500,000	$9,000,000	$9,000,000	$0	
TOTAL	**$99,900,000**	**$489,600,000**	**$589,500,000**	**$283,200,000**	**$306,300,000**	

BASIS FOR PRELIMINARY COST ESTIMATES
SEDIMENT REMEDIATION
FOX RIVER, WISCONSIN
LITTLE RAPIDS TO DE PERE AND DE PERE TO GREEN BAY
Action Level - 1,000 ppb

ALTERNATIVE C2B: Dredge Sediment with Separate Dewatering and Disposal Facilities

SEDIMENT REMOVAL (2 12-INCH CUTTERHEADS)

Capital Items	Quantity	Units		Cost
Site Preparation	3	EA		$2,410,200
Mobilization - Equipment and Silt Curtain	1	LS		$1,170,000
Debris Sweep	1362	acre		$21,792,000
Dredging - 2 12 hour shifts/day	1121	Day	6.15934066	$31,836,400
Dredge Monitoring (Water Quality)	1121	Day		$6,726,000
Sediment Removal QA	1121	Day		$2,690,400
Piping	95,000	ft		$6,365,000
Road Crossings	12	ea		$600,000
Booster Pumps	4	ea		$11,210,000
Winter Over All Equipment	7	yr		$1,995,000
Site Restoration	3	EA		$1,800,000

Direct Capital:	$88,595,000
Engineering, Procurement & Construction Management:	10,631,400
Contractor Overhead/Profit:	13,289,250
Total Capital:	**$112,500,000**

SEDIMENT DEWATERING (GRAVITY - NR 213)

Capital Items	Quantity	Units	Cost
Land Lease or Purchase	13,189,454	sf	$23,741,016
Mobilization	1	LS	$20,000
Clear and Grub	13,189,454	sf	$605,576
Berm Construction	260,294	cy	$1,561,761
Rough Grading	13,189,454	sf	$3,297,363
Liner Placement	13,189,454	sf	$19,784,180
Demob/Disposal	1	LS	$10,000
Regrade	260,294	cy	$1,561,761
Seed/Sod	1,465,495	sy	$1,465,495

Direct Capital:	$52,047,153
Engineering, Procurement & Construction Management:	6,245,658
Total Capital:	**$58,300,000**

WATER TREATMENT

Capital Items	Quantity	Units	Cost
Unit Purchase	3,110	gpm	$2,586,470
Water Treatment (Including Operator)	5,238,315,325	gal	$2,095,326
Water Treatment QA	1,304	Day	$521,600
Piping	20,000	ft	$1,340,000

Direct Capital:	$6,543,396
Engineering, Procurement & Construction Management:	785,207
Total Capital:	**$7,300,000**

BASIS FOR PRELIMINARY COST ESTIMATES
SEDIMENT REMEDIATION
FOX RIVER, WISCONSIN
LITTLE RAPIDS TO DE PERE AND DE PERE TO GREEN BAY
Action Level - 1,000 ppb

SEDIMENT DISPOSAL (Dedicated NR 500 Monofill)

Capital Items	Quantity	Units		Cost
Sediment Loading	6,612,557	ton		$18,515,160
Sediment Hauling	6,612,557	ton		$7,749,090
Landfill Construction	1	LS		$24,467,146
Local Siting Fee	3,906,255	cy		$19,531,275
Closure	121	acres		$12,100,000
Direct Capital:				$82,362,671
Engineering, Procurement & Construction Management:				9,883,521
Total Capital:				**$92,200,000**
Present Worth of Longer Term Operating Costs		**Years**	**Annual Cost**	
Operations		10	$500,000	$3,680,044
Post Closure Monitoring		40	$30,000	$252,053
Total Present Worth, Longer Term O&M Costs				$3,932,097
Total Project Capital and O&M Cost				**$96,100,000**

INSTITUTIONAL CONTROLS

Capital Items	Quantity	Units		Cost
Deed Restrictions	1	LS		$5,000
Direct Capital:				$5,000
Engineering, Procurement & Construction Management:				600
Total Capital:				**$5,600**
Present Worth of Longer Term Operating Costs		**Years**	**Annual Cost**	
Long-term Monitoring (no action)		40	$300,000	$4,513,889
Total Present Worth, Longer Term O&M Costs				$4,513,889
Total Project Capital and O&M Cost				**$9,000,000**
Combined OU 3 and OU 4 COST				**$283,200,000**
Unit cost in $ / cubic yard				**$43.80**

In Situ Volumes

Depost DD	9,000	cy
OU 3	586,800	cy
OU 4	5,879,500	cy

Costs

OU 3 (including DD)	$26,500,000
OU 4	$257,500,000.00
Total Costs	**$284,000,000.00**